IMPACT OF GRAZING PROCESSES ON THE STRUCTURE AND PERSISTENCE OF THIN BIOLOGICAL LAYERS

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LONG TERM GOALS

My long term goal is to understand the functional roles of microzooplankton (20-200 microns) in the sea. It has been argued that on a timescale of days, the instantaneous grazing rate of zooplankton in toto is greater than the instantaneous rates of vertical and horizontal mixing by at least an order of magnitude, and is the same order of magnitude as the instantaneous rate of phytoplankton cell division. Hence, grazing is a critically important loss term in phytoplankton dynamics (Banse, 1992). Because microzooplankton are the major grazers of phytoplankton in pelagic food webs under most circumstances, their grazing impacts exert an important impact on phytoplankton losses in the sea. My specific interests are in the vital rate processes of feeding and reproduction (e.g., Gifford 1988; Gifford, et al. 1995) and in understanding their function as prey for higher organisms (e.g., Gifford and Dagg, 1988; 1989; Gifford 1993).

OBJECTIVES

The objectives of the research are to develop and apply methods which will allow us to define quantitatively the impact of a biological process, grazing, on the structure and persistence of thin layers of biological particles. Specifically, we have examined (1) the impact of microzooplankton grazing within and around thin layers of phytoplankton and (2) the fine-scale (sub-meter) distribution of microzooplankton and phytoplankton in the water column. The research is supported by the U.S. Office of Naval Research, Biological Oceanography program.

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APPROACH

Cm-scale layers are first resolved in the field using a high resolution profiling package (Donaghay et al. 1992) equipped with a siphon system for bulk water collection. The system collects cm-scale measurement of conductivity, temperature, oxygen, pH, Eh, chlorophyll, light extinction, absorbance and scattering, depending on which sensors are mounted on it. Water samples are collected with the siphon at 10-50 cm intervals for analysis of chlorophyll, nanoplankton (2-20 microns) and microplankton (20-200 microns). Microzooplankton grazing is measured by experimental manipulation of water collected with the siphon using the seawater dilution technique (Landry and Hassett 1982; Gifford 1988).

WORK COMPLETED

To date we have collected fine-scale profiles and measured microzooplankton grazing on layers in two coastal locations, the Pettaquamscutt Estuary, RI and East Sound, WA. In the Pettaquamscutt Estuary during August 1996, a 50 cm thick layer dominated by the autotrophic flagellate, *Euglena proxima*, was centered at a depth of approximately 3.6 m. Phytoplankton pigment in the layer was 3 to 10 times higher than in water located above and below the layer. Microzooplankton grazing was measured in water collected from the center of the layer and its upper and lower edges. Grazing rates were approximately equal to phytoplankton growth rates at the three loci. Grazing rates were highly significant within the layer but not above the layer. (rates were not measured below the layer because a permanent anoxic boundary presumably renders them equal to zero).

In East Sound during June 1997, a 2 m thick layer dominated by a declining community of chain forming diatoms was centered at a depth of approximately 5 m. Phytoplankton pigment in the layer was dominated by phaeopigments, and was 6 times more concentrated than in water above and below the layer. Microzooplankton grazing was measured in water collected from within, above and below the layer. Phytoplankton growth rates were approximately equal to grazing rates at the 3 depths, but grazing was significant only above the layer. A fine-scale profile (50 cm sampling intervals) collected under different hydrographic conditions 3 days after the grazing experiments revealed three layers: (1) a 2 m thick surface layer consisting of the dinoflagellate *Dinophysis acuminata* and the silicoflagellate *Distephanus* sp.; (2) a 2 m thick layer of the noxious dinoflagellate *Alexandrium catenella* and small autotrophic nanoflagellates co-occurring with a peak of aloricate choreotrich ciliates which are their potential predators; and (3) a 1.5 to 2 m thick layer consisting of an assemblage of small autotrophic nanoflagellates, the bioluminescent autotrophic dinoflagellate *Ceratium fusus*, the chain forming diatoms *Thalassionema nitzioides* and *Chaetoceros debilis*, an unidentified assemblage of autotrophic dinoflagellates, and a potential microzooplankton predator on these organisms, the heterotrophic dinoflagellate *Gyrodinium* sp.

IMPACT

Our cm-scale profiles of bio-optical, physical, chemical and biological properties document the existence of sub-meter thick layers of phytoplankton and microzooplankton in two coastal environments. Manipulative experiments demonstrate that in one case the layer is a locus of intense grazing activity, and hence functions to maintain the integrity of the layer. In the other case, maximum grazing activity was located above the layer, and may function to maintain the layer's upper boundary. Although the existence of thin layers is now relatively well documented, few measurements of physiological rates have been made within and around them. The grazing rates reported above are the first such measurements in thin layers. Because the layers scatter both sound and light, they are important in a number of other disciplinary areas in ocean including bio-optics and acoustics, as well as basic ecological research.

RELATED PROJECTS

The research is closely linked to other layer studies by P. Donaghay, T. Cowles, A. Alldredge, V. Holliday. R. Pieper, and J. Rines.

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